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Classification of Hydrology

Przegląd Meteorologiczny i
Hydrologiczny, Nos 1-4, pages
3-11; Kasińska Dobosi;
Warsaw: 1949.

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CLASSIFICATION OF HYDROLOGY

Mazimierz Lebski

The matter of systematizing hydrological investigations was discussed in the report (Engineer Tadeusz Zubrzycki, "The Span and Classifications of Hydrological Investigations." Bulletin of the Society of Geophysicists, No. 4-5, Warsaw, 1932) of Engineer Tadeusz Zubrzycki, read at a discussion meeting of the Society of Geophysicists in Warsaw on 12 April 1933. The contents of the report was published in the Bulletin of the Society of Geophysicists (No. 4-5 from the year 1933).

The speaker based himself upon the classification scheme originated by Vereshchagin and improved by Thienemann in 1926. Starting with this scheme the speaker introduced his own attitude toward the span for hydrological investigations and their classification.

The co-report (Engineer Alfred Rundo, "Hydrology and its Relation to Geophysics." Organization for Hydrological Investigations Abroad. The Bulletin of the Society of Geophysicists, No. 4-5, Warsaw, 1932) on this topic (published in loc.cit.) was read at this same meeting by Engineer Alfred Rundo. He discussed the span of investigations usually attached to the concept of hydrology as

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well as the evolution of classification schemes for hydrology as a science, beginning with the philosophical-medical treatise of Eberhard Helchier from the year 1694, through Penck (1898), Glushkov (1915), Prinz (1923), Thienschmann (1926), up to the most recent times (1931).

Since the year 1898, when the work of Penck appeared, to the present day - 30 years have elapsed. The demands of every day life with relation to hydrology as a science have grown considerably. The span of hydrological investigations in all countries has greatly widened and deepened, and the results of these investigations have become broader and more penetrating. Hydrology has been recognized as a part of geophysics.

Imbeaux in his "Essay-Program of Hydrology" (Zeitschrift für Hydrographie / Journal of Hydrology, Volume I, No. 3, 5; Volume II, No. 4, 6) begins with the hypothesis that hydrology is a very important branch of the physics of the ^{terrestrial} earthly globe. The hydrological classification given by Imbeaux for the first time clearly designates hydrology as belonging to geophysics and emphasizes the broadness of its span.

In Poland, Professor Rudzki in his Physics of the Earth in 1909 also discusses a series of

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hydrological topics. Among these were the morphology of oceans, the properties of sea water, waves, tides, currents, energy of rivers and ice phenomena - not touching upon the problems of hydrological balance.

The first official, so to speak, expression of hydrology as a geophysical discipline, encompassing the investigation of phenomena in rivers, lakes, ice-burys and subterranean waters, was in a resolution at a meeting of the International Geodetic-Geophysical Union in Rome in 1922 concerning the opening of a hydrological section in the Union.

On the basis of this resolution, a special commission was created which ascertained the necessity of supplementing the seven existing sections of the Union (geodetic, geomagnetic, meteorologic, magnetic and electric of the earth, oceanographic, and volcanic) by opening a separate seventh section for investigative problems concerning continental waters: rivers, lakes, ice-burys, and subterranean waters.

This section, under the name Section of Scientific Hydrology, was approved at the general meeting of the Union held at Madrid in 1924. Subsequently, it constituted itself into five commissions:

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petamological, limnological, glaciological, subterranean waters, and the application of statistical methods to investigations in the field of hydrology.

It was decided at the third meeting of the Union, held in Prague in 1927, to create a sixth commission for the following: the application of hydrology to the utilization of water. Its purpose was to connect more closely the theoretical investigations with practical problems.

At the next meeting of the Union, held at Stockholm in 1930, the hydrological section was given autonomy and renamed the Association for Scientific Hydrology. (For the participation of the Central Hydrographic Bureau in the work of the Scientific Hydrology Section of the International Geodetic-Geographical Union, see: Engineer Alfred Fando, Organisation et fonctionnement des Services Hydrographiques en Allemagne, Autriche, Hongrie, Pologne et Russie [The Organization and Functioning of the Hydrographic Services in Germany, Austria, Hungary, Poland and Russia], Warsaw, 1934, published by the Ministry for Communications).

The growth in importance of hydrology as a science can be observed on a world scale, and we also see this in Poland.

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This is expressed in the attitude of wide scientific and technical circles toward hydrological problems as well as in the extremely benevolent attitude of the highest government agencies.

The pre-war government hydrographic service was directed by the Hydrographic Institute, subordinate to the Director of the Bureau for Hydrological Affairs in the Ministry for Communications. The present service is conducted by the National Hydrological-Meteorological Institute, directly subordinate to the Minister for Communications.

These just and more profitable organizational changes correspond to the better situation in the service with regard to personnel and material. This is accompanied by an understandable growth in the requirements demanded of the service by organizations interested in the results of hydrological experiments.

In such a situation, the answer to the following question becomes pertinent:

1) What is the span and division of hydrological investigations according to the present status of this branch of science;

2) Which part of these hydrological investigations should be taken over by the National Hy-

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hydrological Institute, and which parts should be conducted by organizations or persons cooperating or directly interested.

The subcommission on hydrological terminology, as part of the science and publications commission in the Society for Hydroelectric Utilization, Engineers and Technicians of the Polish Republic, worked on a modern definition for the concept of hydrology as a science and on a classification scheme for hydrology during the past year.

This sub-commission, under the chairmanship of Professor Engineer Stanislaw Jurczynowicz - and with the participation of members Professor and Doctor of Engineering Edward Gzetrzynski, Professor and Doctor of Engineering Leon Staniewicz, Professor and Doctor Stanislaw Pietkiewicz, and the author of this article - developed the matter during the course of several meetings.

An extract from the protocol made at the last meeting of this subcommission, at which the above matter was discussed, is given below. The meeting took place on 5 February 1969.

During the course of the discussion, a plan was proposed for dividing hydrology as a science according to the following three criteria:

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- 1) according to the type of phenomena investigated (horizontal division),
- 2) according to the processes of investigation (vertical division),
- 3) according to the place of the investigation (horizontal division).

By collection, planned divisions were suggested:

Horizontal division:

- I. Internal or external hydrology (study of the movement of water in nature).
- II. Hydrodynamics with hydrochemistry.
- III. Hydrometeorology.

Vertical division:

1. Hydrography with hydroclimatology.
- II. Hydrodynamics (regional hydrology).
- III. Geomorphology or functional hydrology.

Horizontal division:

1. Cryometeorology (with glaciology and climatology),
- 2a. Iceology.
- 2b. Limnology.
- 2c. Oceanology.
3. Pedohydrology with chronology and pedohydrology. (the term "pedology" [in English] and "pédologie" [in French] mean the study of soils. However,

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confused with "paedology", which designates
the terms are not to be (the study of children and
their nature).

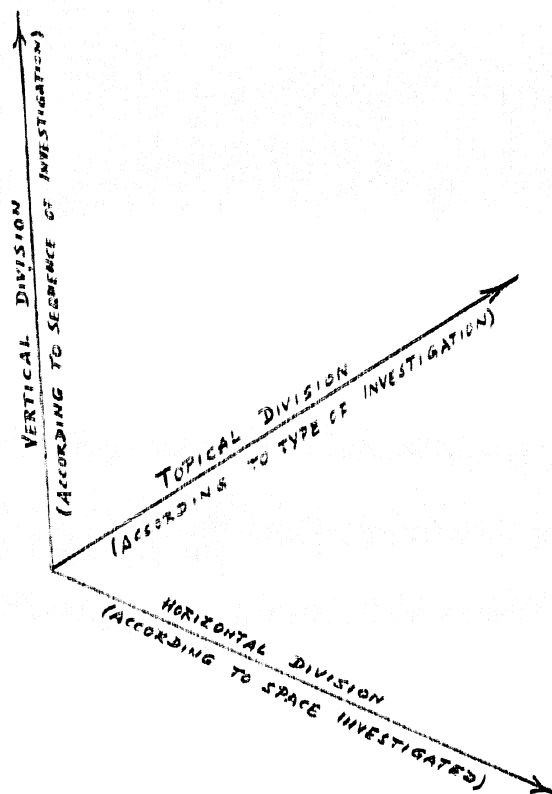


Figure 1.

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The discussion concerning the classification scheme explained in the above protocol was not concluded, but it seems that what was said does exhaust the whole current span of hydrological investigations and makes possible a further differentiation in detail.

According to the basis the criteria established in the protocol of the sub-commission, we can systematize hydrological investigations in a spatial distribution according to three zones (Figure 1).

It will group hydrological investigations according to the space in which the water, as an object of investigation, is situated - along the horizontal axis in the drawing.

The space occupied by water can be as follows:

1) The space above the earth in which we have atmospheric water.

2) Surface space (more accurately: just above the surface), located on higher and lower places, in which we have surface water that flows.

3) Surface space (more accurately: just above the surface), situated on plains and submerged parts of land where we have surface water that

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to standing and inland.

4) the surface occupied by the waters of
the sea and rivers.

5) the underground for distant spaces, between
the earth's surface and the surface of soil and
the great horizon.

6) the underground area in which we have
soil water, in the great horizon.

7) the underground area in which we have
ground water, usually extraction.

According to the foregoing, we will group
the individual sections for hydrological investi-
gations along the horizontal axis going from left
to right as follows:

1. Hydrometeorology - the study of the wa-
ter in the atmosphere.
2. Potamology - the study of flowing water
in surface water crevices.
3. Limnology - the study of territorial,
standing waters.
4. Oceanology - the study of sea waters.
5. Pedohydrology - the study of water con-
tained in the ground, in the zone exposed to the

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wind.

1. pedology - the study of soil water on the first horizon.

2. hydrology - the study of water in deeper waters (in the depths).

Turning back to the classification of the soil-water, we will discuss hydrological investigations according to their sequence along the vertical axis.

We differentiate here three levels, of which each subsequent one starts with the preceding one.

On the first level, we have observations of the water and hydrological phenomena, then all hydrological measurements, and finally experiments in this field.

On the second level, we have a systematization of the results from observations, measurements, and hydrological experiments according to various criteria: the geographical distribution of individual elements investigated, the type of phenomena investigated, the frequency of phenomena, etc.

The third level consists of all investigations having the purpose of explaining the causes and results of individual phenomena in hydrology.

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the establishment of corresponding functional units, and the working out of scientific and practical suggestions.

According to this division, we will group the individual sections of hydrological science along the vertical axis proceeding from the bottom toward the top as follows:

- I. Hydrography - encompassing observations, measurements, and hydrological experiments.
- II. Hydrogeology (or Descriptive Hydrology) - encompassing the descriptions of waters and hydrological phenomena in a geographic, local, or other disposition.
- III. Scientific Hydrology (or Analytical) - encompassing the investigation of causal relations or correlative relations.

The third axis in this spatial disposition proceeds in a perpendicular direction to the surface of the drawing. We will group along this axis hydrological investigations according to their main topic, passing from problems of the water element to problems of the hydrological medium, and finally the phenomena of water circulating in nature.

In this connection, we differentiate between

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the following hydrological divisions:

- A. Hydrochemistry - the study of the chemical composition of water.
- B. Hydrophysics with hydromechanics and hydraulics - the study of the physical properties of water and of the movements of water.
- C. Biogeochemistry - the study of water as a biological medium.
- D. Hydrology proper or circular - the study of the circulation of water in nature. We can accept as a synonym the term: integral hydrology, which corresponds to the concept of the study of the whole hydro-sphere.

In systematizing the object of hydrological investigations by the method described in the foregoing, we obtain a scheme of a division presented on the drawing (figure 2). This is an axonometric view of a rectangular prism, on the axes of which the individual spans of investigation have been written out.

Some sections of hydrology were omitted from those enumerated above, as for example glaciology, cryology, and crenology. These sections concern certain transitory sectors. Glaciology as the study of icebergs stands on the border between hydro-

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meteorology and potamology. It can be investigated in the one sector as well as in the other. The same is true for cryology which is the study of snow and ice in the atmosphere and on the earth's surface.

Crrenology is the study of springs and can enter the sector of geohydrology as well as potamology.

We can see by looking at the schematic presented in drawing 2 how numerous and how differentiated are investigations in hydrology today. The number of sections, which can be differentiated in this disposition is equal to the product of $7 \times 3 \times 4 = 84$ principal sections. By means of a more detailed differentiation, one could make out even more specialized sectors and correspondingly more numerous.

Having this schematic before our eyes, we can consider the span of hydrological investigation that should be taken over by the National Hydrological-Meteorological Institute as an official institution especially designated for such work - and what type of investigation should not burden the Institute.

It would seem that the government hydrological service, which is conducted by the National Hydrological-Meteorological Institute, will suitably

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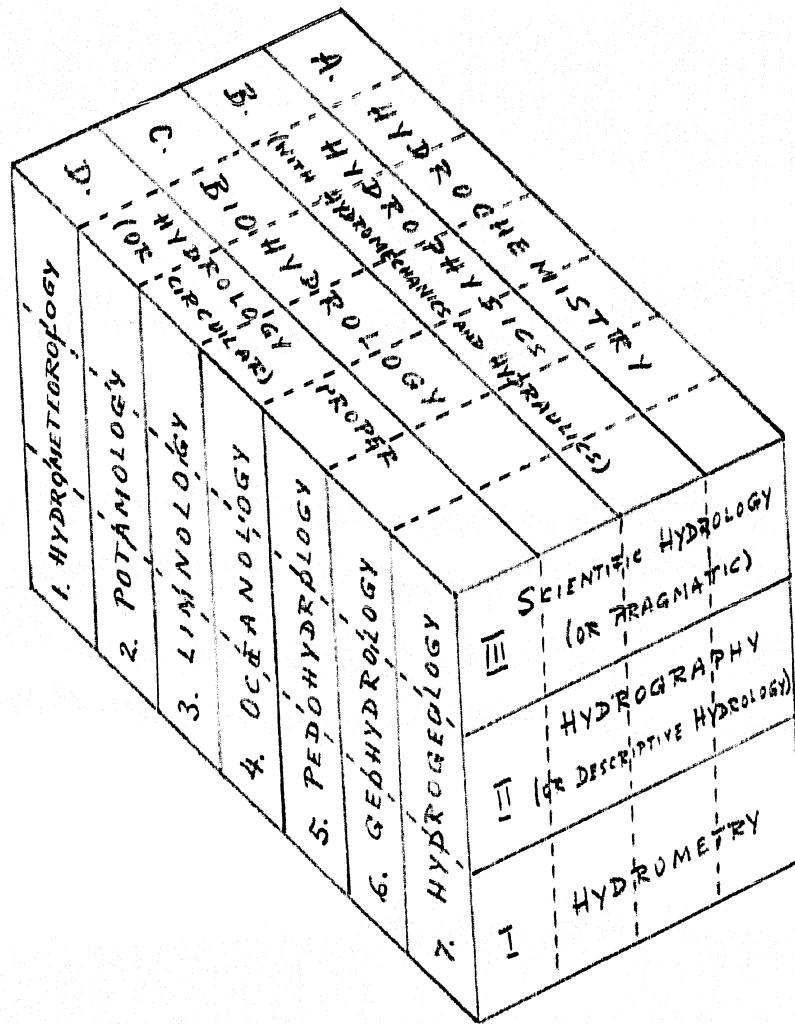


FIGURE 2.

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1. fulfill its task if it will organize and further direct first of all hydrological investigations on the first level of the vertical division, that is, hydrology in its full area.

It will create by doing so a basis for further investigative work in hydrology on higher levels. Advanced work can develop, when the results of observations, measurements, and the experiments conducted on the basic level will be systematically and without reservation made available to the broad technical and scientific circles.

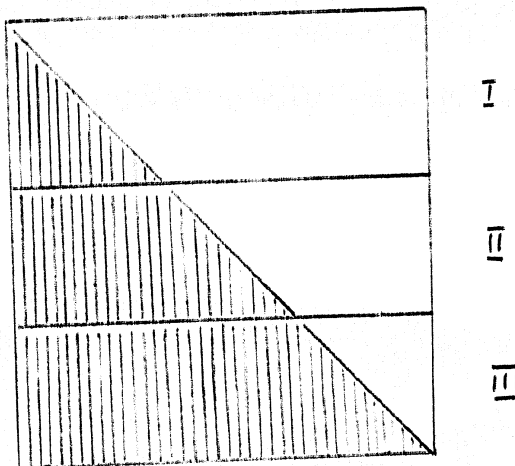


Figure 2

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By such means, a national division of investigative work can be maintained.

The official hydrological service (National Hydrological-Meteorological Institute) would take over the difficult job of constructing the foundations under the building of hydrological knowledge. Institutions and scientific establishments would concern themselves with the higher levels of this building.

The concept of such cooperation was pictured by the new director of the National Hydrological-Meteorological Institute, Doctor and Engineer Julian Isakov with the help of two triangles which are presented on Figure 3.

The triangle with the base at the bottom represents the activities of the National Hydrological-Meteorological Institute - covering all phases of the hydrologic level and working down on the higher levels.

The triangle with the base on top represents the sum of activities for institutions and scientific establishments, far-reaching on the level of scientific hydrology and lessening toward the bottom.

With such a division, a broad field would

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ness up for individual work, which could be conducted in all fields with research and scientific facilities, including the National Hydrological-Meteorological Institute.

(Institute for Water Construction and Hydrology at the Main School for Rural Economy).

SUMMARY

A sub-commission on hydrological terminology, attached to the Society for Hydrological-Meteorological Engineers and Technicians of the Polish Republic worked out a modern definition for the concept of hydrology as a science and a new classification for it.

A division was proposed according to the following three criteria:

- a) a horizontal division, according to the place of the investigated phenomena,
- b) a vertical division, according to the sequence of the investigation,
- c) a topical division, according to the type of phenomena investigated.

Upon the preceding basis, the author makes a detailed division along lines of each criterion:

- a) horizontal division

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- a. "hydrogen technology"
- b. "hydrogen"
- c. "hydrogen"
- d. "hydrogen"
- e. "hydrogen"
- f. "hydrogen"
- g. "hydrogen"

1) Vertical Division

- i. "hydrogen"
- ii. "hydrogen" or "hydrogen"
- iii. "hydrogen"

e) "hydrogen"

- A. "hydrogen"
- B. "hydrogen"
- C. "hydrogen"
- D. "hydrogen"

A sketch of the "hydrogen" division is presented on figure 2.

- END -

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